

PHOTOPRODUCTION OF JETS AT NLO^a

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A new next-to-leading order Monte Carlo program for the calculation of fully differential jet cross sections in photoproduction is described. The contributions from both resolved and direct components are included. A comparison between the theoretical predictions and ZEUS data is presented.

1 Introduction

The production of jets with large transverse momenta by photon beams differs in a number of ways from the corresponding hadroproduction case. These differences can be used to further investigate the interactions of the underlying hadronic constituents as well as to study the interactions between photons and hadrons¹. It has become conventional to describe jet photoproduction in terms of two components. One is referred to as the direct component wherein the photon participates directly in the hard scattering subprocess. The other is called the resolved component and corresponds to a situation where the photon interacts as if it contained partons.

2 Method

The calculation was performed using the phase space slicing method as was done in a previous study which included only the direct component at next-to-leading order (NLO)². Briefly, two cutoffs are used to isolate the regions containing soft and collinear singularities from the remainder of the three-body phase space. The three-body squared matrix elements are integrated over these singular regions analytically. The soft singularities cancel upon addition of the virtual contributions and the remaining collinear singularities are factorized into the parton distributions. The integrations over the singularity free portions of the three-body phase space are performed using Monte Carlo methods. When all of the contributions are combined at the histogramming stage the various cutoff dependences cancel, since the cutoffs merely mark the boundary between the region where the integrations were performed using analytic or Monte Carlo methods.

^aPresented at the 1996 Meeting of the American Physical Society, Division of Particles and Fields (DPF 96), Minneapolis, Minnesota, 10-15 Aug 1996.

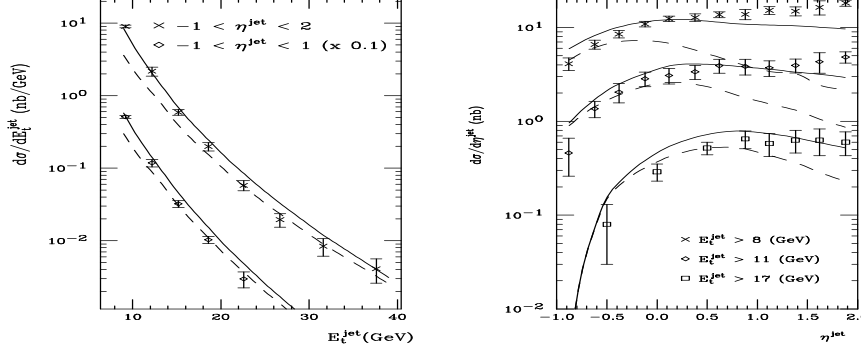


Figure 1: Single inclusive jet cross section predictions compared to ZEUS⁷ data.

3 Results

Results are presented for HERA where 27.5 GeV positrons are collided with 820 GeV protons. Virtualities Q^2 of the photon are incorporated using the Weizsäcker-Williams approximation³. We have used the two loop strong coupling with $n_f = 5$, the proton distribution functions of CTEQ⁴, and the photon distributions of GRV⁵, all in the $\overline{\text{MS}}$ scheme and all evaluated at $\mu_f = \mu_r = E_t^{max}/2$ where E_t^{max} is the maximum E_t^{jet} of the event. The Snowmass jet convention⁶ is used with $R = 1$.

The separation between direct and resolved components is only well defined at leading order. Following ZEUS, the fraction of the photon energy contributing to the production of the two highest transverse energy jets x_γ^{OBS} is used to define these kinematic regions.

Shown in Figure 1 are jet photoproduction cross sections for the kinematic range $0.2 < y < 0.85$ and $Q^2 < 4\text{GeV}^2$ as measured by ZEUS⁷ for various cuts on E_t^{jet} and η^{jet} . The solid lines are NLO QCD including both direct and resolved components. The dashed line is direct only ($x_\gamma^{OBS} \geq 0.75$). It is clear from these results that both components are required by the data.

In Figure 2 $\cos\theta^*$ and $\bar{\eta}$ distributions from ZEUS⁷ are shown for dijet production. Here $\bar{\eta} = (\eta^{jet_1} + \eta^{jet_2})/2$ and θ^* is the angle between the dijet axis and the beam axis in the dijet rest frame. The steeper slope of the resolved component as compared to the direct component is readily apparent, as noted by ZEUS⁷. The higher order corrections to the $\bar{\eta}$ distribution for the direct component improve the agreement with the data relative to the leading order prediction shown as a dotted line.

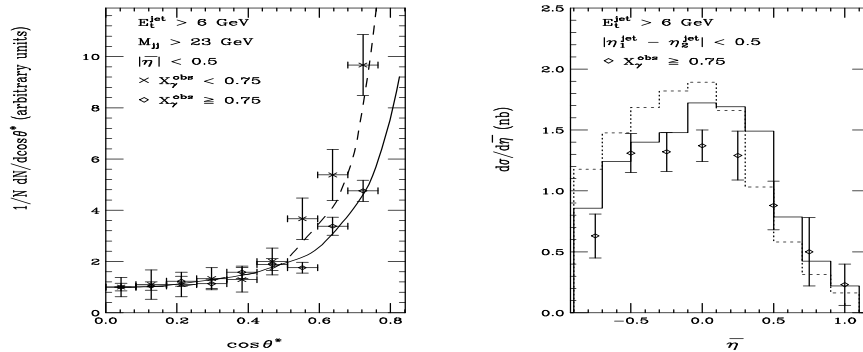


Figure 2: Two jet cross section predictions compared to ZEUS⁷ data.

4 Conclusion

Our results agree with the already available single inclusive results of Klasen *et al.*⁸ and Aurenche *et al.*⁹. Each of the examples given here has required placing cuts on several different variables. The flexibility of the Monte Carlo approach has enabled us to calculate all of these simultaneously. A thorough comparison with all available data is currently in progress.

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